## What Is Claimed Is:

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- 1. An apparatus for detecting an analyte, comprising:
  - (a) an integrated circuit including a light detection system;
  - (b) a selectively permeable container attached to a substrate located on said integrated circuit;
  - (c) a layer of semiconducting material between said substrate and said container.
  - (d) a microorganism housed within said container wherein the microorganism metabolizes a selected analyte to emit light in response to a metabolite of said analyte;
  - (e) a semiconductive layer between the substrate and the container; and
  - (f) a fluid nutrient reservoir equipped with a microfluidic pump on said substrate.
- 2. The apparatus of claim 1 wherein the semiconductor layer is a metal oxide.
- 3. The apparatus of claim 2 wherein the metal oxide is a complementary metal oxide layer that includes a photodiode, a current to frequency converter, a digital counter, and a wireless transmitter.
- 4. The apparatus of claim 3 further comprising a central data collection station to receive transmissions from said transmitter.

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- 5. The apparatus of claim 1 wherein the microorganism is *Pseudomonas fluorescens* HK44.
- 6. A biosensor for detection of ammonia, comprising:

an integrated circuit chip comprising a microorganism that metabolizes ammonia and which harbors a *lux* gene fused with a heterologous promoter gene stably incorporated into the chromosome of said microorganism wherein the microorganism is held sufficiently close to a light detection system located on the chip to detect light emitted by a *lux* gene product expressed in the presence of ammonia.

- 7. The biosensor of claim 6 wherein the microorganism is a bacterium that metabolizes ammonia and which is identified as *E. coli*, *Pseudomonas putida F1* or *Pseudomonas HK44*.
- 8. The biosensor of claim 7 wherein the bacterium is a nitrifying bacterium.
- 9. The biosensor of claim 8 wherein the nitrifying bacterium is a nitropseudomonad.
- 20 10. The biosensor of claim 9 wherein the nitrifying bacterium is N. europaea.
  - 11. The biosensor of claim 6 wherein the *lux* fusion comprises *lux CDABC* genes fused with a promoter responsive to the presence of ammonia.
- The biosensor of claim 11 wherein the promoter comprises a hao or amo promoter.
  - 13. The biosensor of claim 6 wherein the microorganism is encapsulated in a light permeable material.

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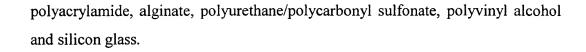
- 14. The biosensor of claim 13 wherein the light permeable material is an encapsulating matrix selected from the group consisting of polydimethylsiloxane, polyvinyl alcohol/polyvinylpryidine copolymer, latex copolymer, agar/agarose, carrageenan, polyacrylamide, alginate, polyurethane/polycarbonyl sulfonate, polyvinyl alcohol and silicon glass.
- 15. An apparatus comprising the biosensor of claim 6.
- 16. The biosensor of claim 7 wherein the microorganism is selected from the group consisting of E. coli, Salmonella, Mycobacter tuberculosis, Listeria, Photobacter phosphoreum or Vibrio fischeri.
  - 17. A method for detecting the presence of ammonia, comprising contacting a sample suspected of containing ammonia with the biosensor of claim 6 and detecting the light emitted by the *lux* gene product that is induced by the presence of ammonia.
  - 18. A biosensor for the detection of an estrogen, comprising a collection of eukaryotic cells harboring a recombinant lux gene from a high temperature microorganism wherein said gene is operably linked with a heterologous promoter and wherein a detectable light-emitting *lux* gene product is expressed in the presence of said estrogen.
  - 19. The biosensor of claim 18 wherein the high temperature microorganism is bioluminescent.
  - 20. The biosensor of claim 19 wherein the bioluminescent microorganism is Xenorhabdus luminescens, Pseudomonas phosphoreum, or photobacterium phosphoreum.

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- 21. The biosensor of claim 18 wherein the estrogen is estrone, estradiol, estriol or an esterified estrogen.
- 22. An apparatus comprising the biosensor of claim 18.
- 23. The apparatus of claim 22 further comprising an integrated circuit chip on which the biosensor is located and wherein said chip comprises an integrated light detection system.
- 24. A method for the detection of an estrogen compound comprising contacting a sample suspected of containing an estrogen with the biosensor of <u>claim 18</u> and detecting the presence of emitted light from a product expressed by the *lux* gene wherein said expression is induced in the presence of the estrogen compound.
- The method of claim 24 wherein the emitted light is detected by the apparatus of claim 23.
  - 26. A luminometer for the detection of an estrogen compound comprising the biosensor of claim 18 and an integrated chip that includes a photodetector wherein said eukaryotic cell collection is held on the integrated chip surface and responds to the presence of estrogen by expressing a bioluminescent protein from the *luxABCDE* gene wherein bioluminescence of said protein is detected by the photodetector.
  - 27. The luminometer of claim 26 wherein the eukaryotic cell collection is encapsulated in a sol-gel matrix held on the integrated chip surface.
  - 28. The luminometer of claim 27 wherein the sol-gel encapsulation matrix is selected from the group consisting of polydimethylsiloxane, polyvinyl alcohol/polyvinylpryidine copolymer, latex copolymer, agar/agarose, carrageenan,

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- 29. A luminometer for the detection of ammonium ion comprising:
  - an expression vector comprised within a transformed prokaryotic cell harboring a *lux* gene fused with a heterologous promoter gene stably incorporated into the chromosome of said cell wherein said gene expresses a bioluminescent protein in the presence of ammonia; and an integrated circuit that comprises a photodetector to detect light emitted by
  - said bioluminescent protein in the presence of ammonia.
- 30. The luminometer of claim 29 further comprising a current to frequency converter.
- 31. The luminometer of claim 30 further comprising a digital counter.
- 32. The luminometer of claim 31 further comprising a wireless transmitter.
- 33. An integrated microluminometer comprising an integrated circuit chip that includes a CMOS photodiode, a detector and an n-well/p-substrate junction arranged in an array of junctions across the detector active region.
- 34. The integrated microluminometer of claim 33 further comprising an analog integrator and a current-to-frequency converter.
- 25 35. A method of measuring bioluminescence, comprising:
  contacting a modified bioluminescent microorganism that emits light in the presence of a selected analyte with a sample suspected of containing said analyte, operating the microluminometer of claim 34 at reduced bias and counting light pulses produced for a fixed time to determine photocurrent wherein said photocur-

rent is proportional to number of pulses that measure bioluminescence when said analyte causes the bioluminescent microorganism to emit light.